CS18000: Problem Solving and Object-Oriented Programming

Selection

(revised 11/24/23)

Video 1
The if statement

Selection

Booleans, Relations, and Selection Statements

Sequential Execution

- By default, a list of statements…
  - Statement 1;
  - Statement 2;
  - …
  - Statement N;
- …is executed in order, one after another
- …unless there is an error (“exception”), all statements are executed
- We say, “Control flows sequentially.”

Control Structures

- Language features (syntax) that affect the flow of control in a program
- Default control flow is sequential
- Control flow jumps to methods, then returns
- Various keywords introduce changes to the default flow

```
if
switch
while
for
```

The if Statement

```
if (boolean-expression)
   then-statement;
next-statement;

if (boolean-expression)
   then-statement;
else
   else-statement;
next-statement;
```

Decision Making

- If it is a weekday and I’m not on vacation, then I will get up early
- If there is a basketball game on and Purdue is playing, I’ll cheer for Purdue, otherwise if IU is playing, I’ll cheer for their opponent

Primitive Type: boolean (Review)

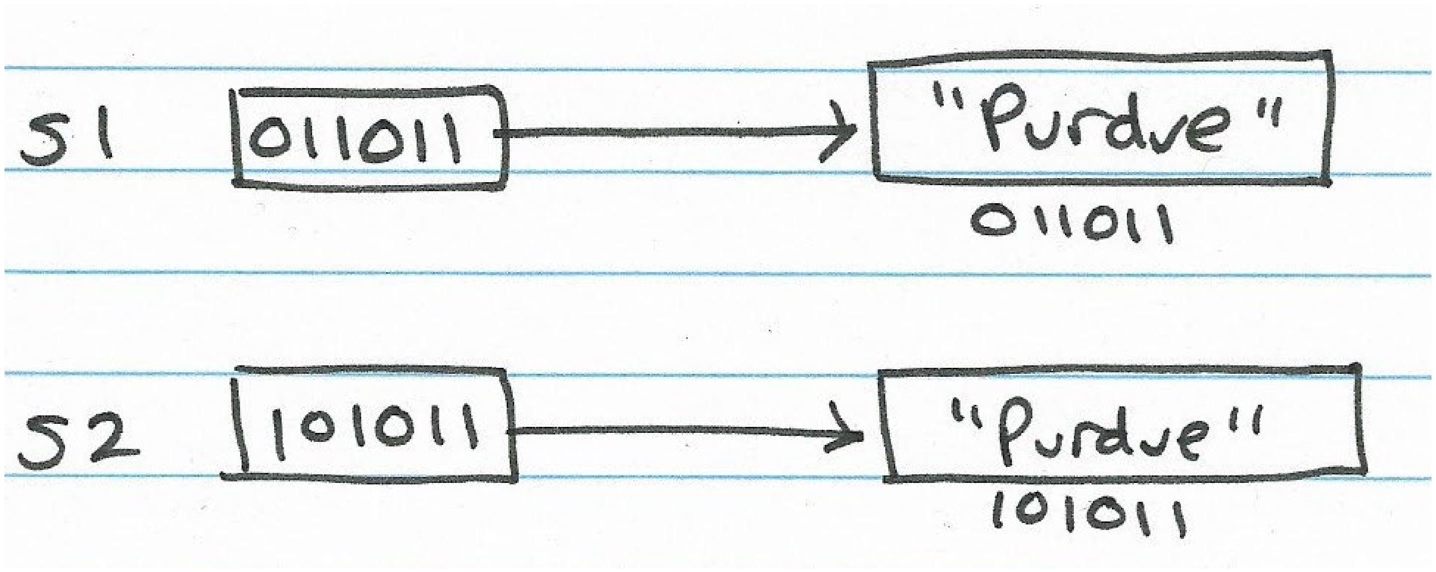
- Set of two elements { true, false }
- Set of operations
  - Logical: && (and), || (or), ^ (xor), and ! (not)
  - Testing in various Java statements (e.g., if)
- Created by comparison operators
  - x < y, x <= y, x == y, x != y, x > y, x >= y
  - And result of logical operators (above)
  - Note: == and != also work with reference types, but only compare references (addresses) not the values

Comparing Strings

- == does not work in the way you might expect
- Strings are objects
- == between objects only compares the references (addresses) of the objects
- Two different String objects with the exact same characters will compare == false (since their objects are stored in different locations)
- `if (s1.equals(s2))`

```
    then-statement;
```

Comparing Strings



Abstracting Conditions

- If it is a weekday and I'm not on vacation, then I will get up early

```
if (isWeekday && !onVacation)
    getUpEarly();
```

- If there is a basketball game on and Purdue is playing, I'll cheer for Purdue, otherwise if IU is playing, I'll cheer for their opponent

```
if (gameOn(basketball) && playing(purdue))
    cheerFor(purdue);
else if (gameOn(basketball) && playing(iu))
    cheerFor(opponent(iu));
```

Video 2
Examples using if statements

Problem: SecretWord

- Write a program that reads a word from the user and prints a message if it matches a “secret word” in the program.

Solution: SecretWord

```
import java.util.Scanner;

public class SecretWord {
    final static String SECRET = “awesome";

    public static void main(String[] args) {
        Scanner in = new Scanner(System.in);
        String word = in.next();

        if (word.equals(SECRET))
            System.out.printf(
                "You have said the secret word: '%s'\n",
                SECRET);
    }
}
```

Problem: Absolute Value

- Write a program that illustrates how to convert the value in a variable x to the absolute value using an if statement

Solution: Absolute Value

```
import java.util.Scanner;

public class AbsVal {
    public static void main(String[] args) {
        Scanner in = new Scanner(System.in);
        int x = in.nextInt();

        System.out.printf("BEFORE: x = %d\n", x);

        if (x < 0)
            x = -x;

        System.out.printf("AFTER: x = %d\n", x);
    }
}
```

Solution: Absolute Value

```
x = 37
BEFORE: x = 37
AFTER: x = 37

x = -41
BEFORE: x = -41
AFTER: x = 41
```

Problem: DaisyDriveIn

- If you work more than 20 hours at the Daisy Drive-in, they pay you $16/hour for first 20 hours plus $20/hour for all hours above 20. Otherwise, they pay you $14/hour
- Write a method…

```
double computePay(double hours)
```

- that returns the correct pay

Solution: DaisyDriveIn

```
public class DaisyDriveIn {
    double computePay(double hours) {
        if (hours > 20)
            return 16.00 * 20 + (hours - 20) * 20.00;
        else
            return hours * 14.00;
    }

    public static void main(String[] args) {
        DaisyDriveIn d = new DaisyDriveIn();
        double pay;

        pay = d.computePay(20); // pay should be 280
        pay = d.computePay(21); // pay should be 340
        pay = d.computePay(9.5); // pay should be 133
        pay = d.computePay(9.1); //pay should be 127.40
    }
}
```

Video 3
More complex if statements

More Selection Statements

A few more if-else examples

switch statement

Boolean Operations

A	B	A || B	A && B	A ^ B
True	True	True	True	False
True	False	True	False	True
False	True	True	False	True
False	False	False	False	False

Problem: Median

- Write a method…

```
double median(double a, double b, double c)
```

- This example illustrates cascading if-else-if statements

Solution: Median

```
 double median(double x, double y, double z) {
    if (x <= y && y <= z || z <= y && y <= x)
        return y;
    else if (y <= x && x <= z || z <= x && x <= y)
        return x;
    else if (x <= z && z <= y || y <= z && z <= x)
        return z;
    else
        return 0;
}
```

Solution: Median

```
 x = 12  y = 14  z = 27
median is y
 x = 14  y = 27  z = 12
median is x
 x = 24  y = 15  z = 18
median is z
```

Basic Forms of the "if" Statement

```
if (boolean-expression)
   statement-if-true;

if (boolean-expression)
   statement-if-true;
else
   statement-if-false;
```

Blocks and Braces

- Use braces ({}) to group a sequence of statements into a single unit
- Already seen with method bodies and other examples
- Also can be use for control structures

Block Forms of the “if” Statement

```
if (boolean-expression) {
   list-of-statements-if-true;
}

if (boolean-expression) {
   list-of-statements-if-true;
} else {
   list-of-statements-if-false;
}
```

Video 1
Examples using complex if statements

Problem: Swapper

- Write a program that, given two values in variables x and y, ensures that y is not less than x (swap them if necessary)

Solution: Swapper

```java
import java.util.Scanner;

public class Swapper {
    public static void main(String[] args) {
        Scanner in = new Scanner(System.in);

        int x = in.nextInt();
        int y = in.nextInt();

        System.out.printf("BEFORE: x = %d, y = %d\n", x, y);

        if (y < x) {
            int t = x;
            x = y;
            y = t;
        }

        System.out.printf("AFTER: x = %d, y = %d\n", x, y);
    }
}
```

Solution: Swapper

```
x = 36  y = 52
BEFORE: x = 36, y = 52
AFTER: x = 36, y = 52

x = 63  y = 18
BEFORE: x = 63, y = 18
t = 63  x = 18  y = 63
AFTER: x = 18, y = 63
```

Problem: Quadratic

- Write a method…

```
void printRoots(double a, double b, double c)
```

- that finds and prints the roots of a quadratic equation (including imaginary roots)

$ax^2 + bx + c = 0$

$2x^2 - 9x + 4 = 0$

```
a=2  b=-9  c=4

d = 81-32 = 49

x1=4.0  x2=0.5
```

Solution: Quadratic

```java
// Reference: http://www.1728.org/quadratc.htm

public class Quadratic {
    void printRoots(double a, double b, double c) {
        double d = b * b - 4 * a * c;

        if (d < 0) {
            double x = -b/(2*a), xi = Math.sqrt(-d)/(2*a);
            System.out.printf("%.2f+%.2fi and %.2f-%.2fi are imaginary roots of %.2fx^2 + %.2fx + %.2f\n",
                              x, xi, x, xi, a, b, c);
        } else {
            double x1 = (-b + Math.sqrt(d))/ (2 * a);
            double x2 = (-b - Math.sqrt(d))/ (2 * a);
            System.out.printf("%.2f and %.2f are real roots of %.2fx^2 + %.2fx + %.2f\n",
                              x1, x2, a, b, c);
        }
    }

    public static void main(String[] args) {
        Quadratic q = new Quadratic();
        q.printRoots(3, 4, 5);
        q.printRoots(2, 4, -30);
        q.printRoots(12, 5, 3);
    }
}
```

Problem: FileExtensions

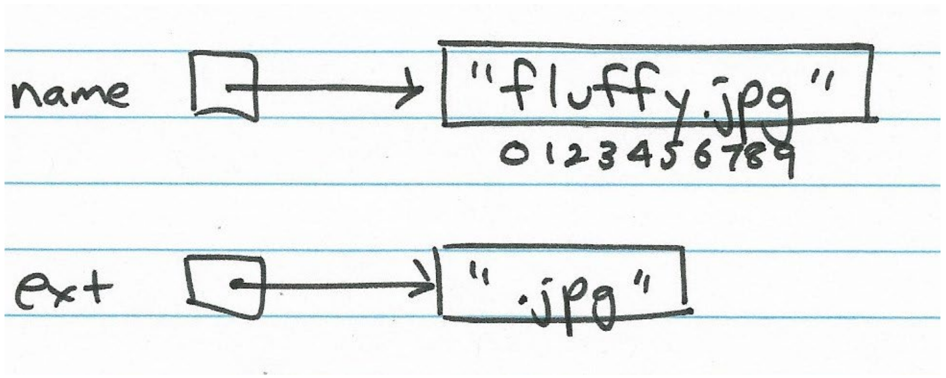
- Write a method…

```
String findExtension(String filename)
```

- that finds the extension in String `filename`.
- Example illustrates short-circuit evaluation

Problem: FileExtensions

```
String name = new String (“fluffy.jpg”);
```



```
String ext = findExtension (name);

substring [begin, end)
[0.0,100.0) starts at 0.0 and goes up to but does
not include 100.0
[6,10) is 6, 7, 8, 9
```

FileExtensions (Version 1)

```
String findExtension(String fname) {
    int dot;

    if (fname == null)
        return "";

    dot = fname.indexOf('.');

    if (dot == -1)
        return "";

    String extension = fname.substring(dot, fname.length());

    return extension;
   }
```

Strings, Empty Strings, Null Pointers

```
String fname = new String ("fluffy.jpg");
```

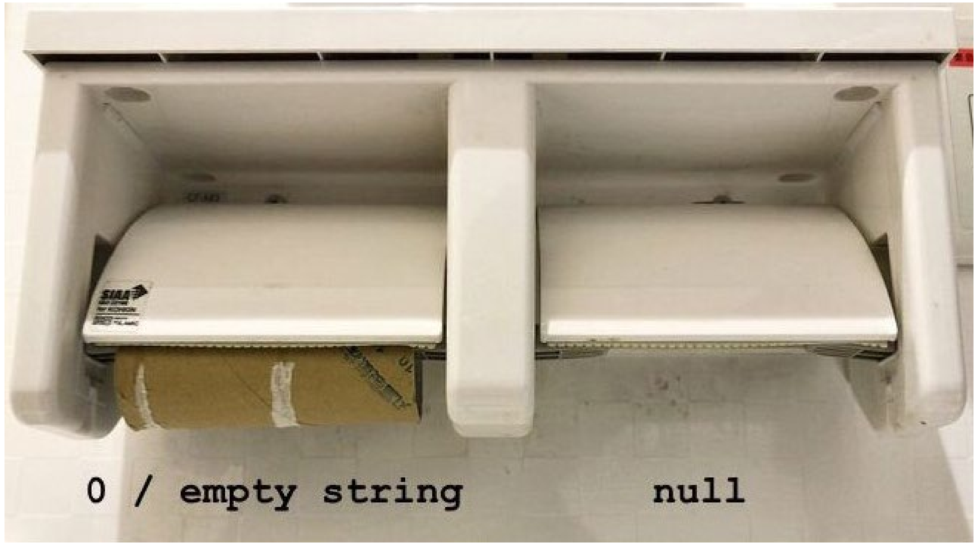
fname points to the object that contains the string "fluffy.jpg"

```
String fname = new String ("");
```

fname points to the object that contains the string "" (empty string)

```
String fname = null;
```

fname does not point to a string. It is a null pointer.



FileExtensions (Version 2)

```
String findExtension(String fname) {
       int dot;

       if (fname == null || fname.indexOf('.') == -1)
           return "";

       dot = fname.indexOf('.');

       String extension = fname.substring(dot, fname.length());

       return extension;
   }
```

Short-Circuit Evaluation

- The Boolean operators && (and) and || (or) abandon evaluation if the result is determined with certainty, e.g., no matter what "whatever" is

```
true || (whatever) -> must be true
false && (whatever) -> must be false
```

- In these cases, "whatever" is *not* evaluated
- Common use:

```
p != null && p.isImportant()
```

  – Second expression would cause null pointer exception if p were null

Video 2
Special cases with if statements

Dangling Else Problem

```
if (familyVisiting)
    if (isWarmOut)
        goToPark();
else
    hangoutWithFriends();
```

- The else clause goes with the most recent if, not as formatted above

```
if (familyVisiting)
    if (isWarmOut)
        goToPark();
    else
        hangoutWithFriends();
```

- Use braces to disambiguate

Problem: ChangeBack

- Comparing real valued quantities for equality
- You gave the waiter a $10 bill

```
    double paid = 10.00;
```

- The check was $9.10

```
    double check = 9.10;
```

- The waiter gave you 90 cents back

```
    double change = 0.90;
```

- Is it correct?

```
    (paid – check) == change
```

Solution: ChangeBack

```
public class ChangeBack {
    double computeChange(double check, double paid) {
        return paid - check;
    }

    public static void main(String[] args) {
        ChangeBack c = new ChangeBack();
        double change;

        change = c.computeChange(8, 10); // 2.00
        change = c.computeChange(9.10, 10); // 0.90
    }
}
```

Comparing Real Values

- Since real numbers represented with double and float are imprecise…
- Comparisons may fail when they shouldn't
- Common trick:
  - Replace…
    ```
    if (x == y)
    ```
  - By…
    ```
    if (Math.abs(x – y) < epsilon)
    ```
  - For some small value, epsilon

```
if (Math.abs(c.computeChange(9.10, 10) – 0.90) < 0.001) {…}
```

Ternary Assignment Operator

- A common situation is to assign one of two alternative values depending on a condition

```
if (a < b)
          minVal = a;
     else
          minVal = b;
```

- We can use the following equivalent statement

```
minVal = (a < b)? a : b;
```

Video 3
Switch statement

Problem: Days

- Write a method that returns the number of days in a given month from a given year

```
int daysInMonth(int month, int year)
```

Solution 1: Days

```
int daysInMonth1(int month, int year) {
       if (month == 1) // January
           return 31;
       else if (month == 2) {
           LeapYear ly = new LeapYear();
           if (ly.isLeapYear(year))
               return 29;
           else
               return 28;
       }
       else if (month == 3)
           return 31;
       else if (month == 4)
           return 30;
       else if (month == 5)
           return 31;
       else if (month == 6)
           return 30;
       else if (month == 7)
           return 31;
       else if (month == 8)
           return 31;
       else if (month == 9)
           return 30;
       else if (month == 10)
           return 31;
       else if (month == 11)
           return 30;
       else if (month == 12)
           return 31;
       return -1;
   }
```

Solution 2: Days

```
 int daysInMonth2 (int month, int year) {
    switch (month) {
        case 1: case 3: case 5: case 7: case 8: case 10: case 12:
            return 31;
        case 4: case 6: case 9: case 11:
            return 30;
        case 2:
            LeapYear ly = new LeapYear();
            if (ly.isLeapYear(year))
                return 29;
            else
                return 28;
    }
    return -1;
}
```

Solution 2: Days (arrow case labels)

```
 int daysInMonth2 (int month, int year) {
    switch (month) {
        case 1, 3, 5, 7, 8, 10, 12 -> {
            return 31;
        }
        case 4, 6, 9, 11 -> { // right hand side of the arrow has to be
                              // an expression or block
            return 30;
        }
        case 2 -> {
            LeapYear ly = new LeapYear();
            if (ly.isLeapYear(year))
                return 29;
            else
                return 28;
         }
    }
    return -1;
}
```

Solution 2: Days (switch expressions, arrow case labels, yield statements)

```
 int daysInMonth2 (int month, int year) {
    int numberOfDays;
    numberOfDays = switch (month) {
        case 1, 3, 5, 7, 8, 10, 12 -> 31; // can just put value here
        case 4, 6, 9, 11 -> 30; // and here
        case 2 -> { // in a block must use “yield”
            LeapYear ly = new LeapYear();
            if (ly.isLeapYear(year))
                yield 29;
            else
                yield 28;
         }
         default -> -1:
    }; // switch expression form has to end in a semicolon
    return numberOfDays;
}
```

Problem: what stuff

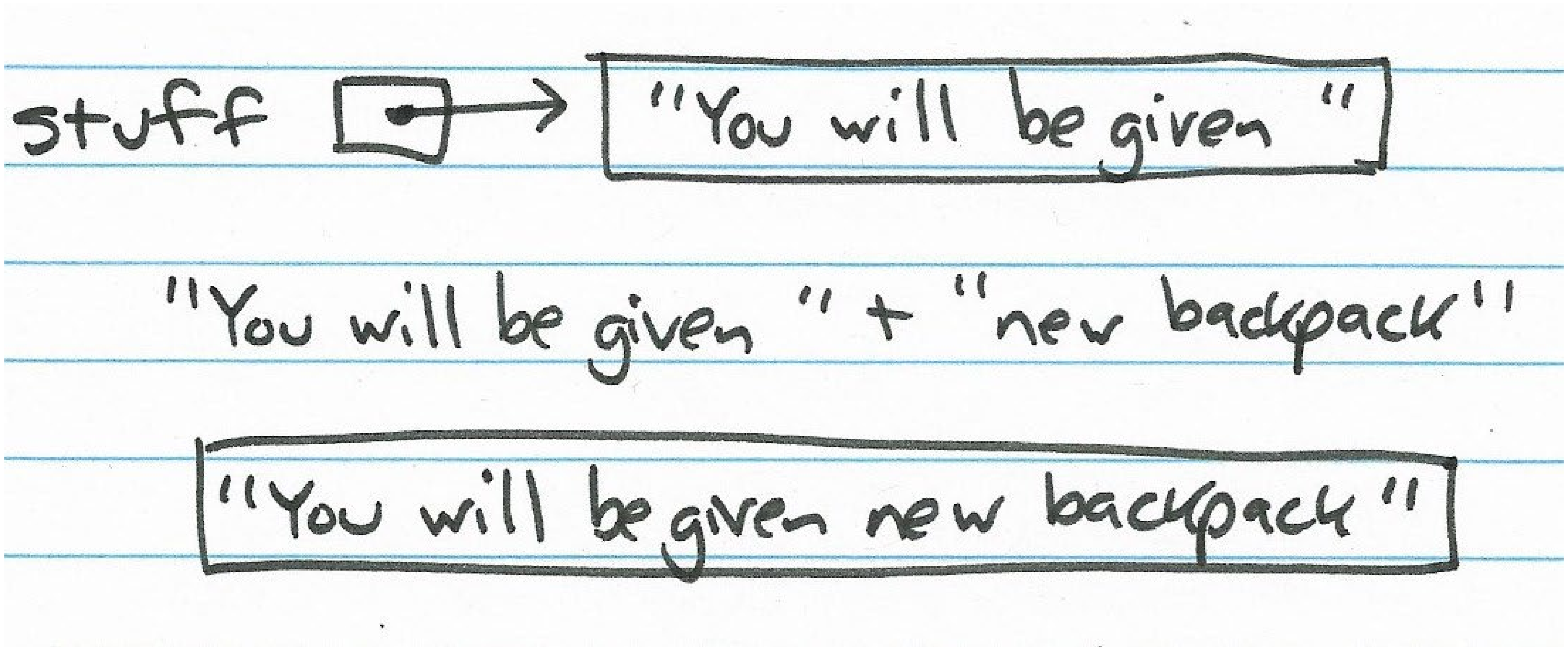
- Write a method that returns a string saying what stuff students are given based on their year in college:
- Seniors (4) and Juniors (3) get a new backpack
- Sophomores (2) get a new coat
- Freshmen (1) get new gloves and a new coat

```
String whatStuff (int yearInCollege)
```

Solution: what stuff

```
 String whatStuff (int yearInCollege) {
    String stuff = “You will be given ”;
    switch (yearInCollege) {
        case 1:
            stuff = stuff + “new gloves “;
        case 2:
            stuff = stuff + “new coat“;
            break;
        case 3: case 4:
            stuff = stuff + “new backpack“;
            break;
        default:
            stuff = stuff + “nothing“;
            break;
    }
    return stuff;
}
```

Solution: what stuff


stuff
"You will be given "
"You will be given " + "new backpack"
"You will be given new backpack"

Switch can use Strings

```
 String whatStuff (String yearInCollege) {
    String stuff = “You will be given ”;
    switch (yearInCollege) {
        case “Freshman”:
            stuff = stuff + “new gloves “;
        case “Sophomore”:
            stuff = stuff + “new coat“;
            break;
        case “Junior”: case “Senior”:
            stuff = stuff + “new backpack“;
            break;
        default:
            stuff = stuff + “nothing“;
            break;
    }
    return stuff;
}
```